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1. Aims / objectives

- (as per email circulated 10-1-07) copied below with the addition of a discussion of the RE testing of the SPIRE DRCU

Table 1

Hi All,

Would you please confirm your attendance at the SPIRE EMC meeting on Friday? The meeting will start at 10:00 and finish mid-afternoon.

The topics for discussion include:

1. Given that we have unequivocally seen detector heating during RS EMC Testing at OTN and ESTEC:
   - How can we assess the probability that this will cause degradation of the performance of SPIRE in flight?
   - On the basis of this assessment and the testing carried out to date, what steps need to be taken to declare SPIRE compliant (or to agree to close out the non-complicance with an RFW)?
   - How will the E-Field around SPIRE be amplitude modulated in flight (depth and spectral content)
   - Have we exhausted all the possibilites for EMC counter measures?
2. We also need to (re)examine some aspects of the physics behind the susceptibility..
   - Why are some pixels more susceptible than others?

2. Revisited Susceptibility Threshold Criteria (Matt)

- Matt has circulated an email detailing his revised EMI susceptibility criteria. (See Table 2 below).

Table 2

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Hello all,

I had an action from the EMC meeting on August 10:

Action: Matt to define allowable increase in noise and bolometer
temperature based on 15% overall increase in rms noise level or
equivalent increase in bolometer operating temperature.
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Comments:

* I have chosen to reinterpret the action slightly as follows:

1. What amount of steady bolometer heating will produce a 15% increase in overall NEP (i.e., quadrature sum of detector and photon noise NEPs). This corresponds to a 15% degradation in sensitivity (equivalent to a 30% loss in observing speed).

2. What additional white noise component at the detector will increase in the overall noise level at the detector output by 15% (this might not be from detector heating).

(Based on the STM-2 test results, it appears that the first case is the most relevant for us).

- The second case could arise due to broadband excess noise being introduced in some way.

* I have addressed this action by running the Photometer sensitivity model (currently under review, but not in a way that would nullify this analysis).

* I take the photometer PMW channel as a typical example (I think the results for the other channels will be much the same).

* The nominal bolometer temperature currently assumed is To = 310 mK. Running the model for various temperatures, I find that a 15%increase in overall NEP is produced by an increase iin To to 333 mK.

Conclusion: Bolometer heating by approx. 25 mK increases the NEP by 15%

* The nominal noise level for is 19.4 nV Hz-1/2. An additional white noise component of 11 nV Hz-1/2 added in quadrature will bring the level up by 15% to 22.3 nV Hz-1/2.

Conclusions:

* The level of steady heating required to degrade the sensitivity is much higher than was observed in the STM-2 campaign.

* If the heating is modulated at frequencies within the signal bandwidth (up to say 25 Hz) then a corresponding signal (maybe very large) will be injected on the detector outputs. The extent of the problem will depend on the nature and stability of the modulation.

Cheers,

Matt

- Discussion:
  - Direct and stable heating of the detectors does not seem to be an issue
  - Heating of the detectors within our signal band is much more problematic (a factor of 10^5)
  - Check irradiation levels for load curve **(AI-1)**

- o The key question therefore is: “What is the probability that the field strength at ~32MHz will be amplitude modulated within our detector signal band in flight?”
- o It has been determined that the strength of the EMI signal from the detectors is proportional to $(V/m)^2$
  - ▪ A consequence of this is that *high* degree of amplitude stability is required for channels undergoing a significant level of EMI heating. For channels with a low level of EMI heating, less AM stability is required.
    - DKG to reprocess STM2 data to produce a plot of the allowable depth of AM modulation (within the SPIRE detection band) vs. Applied EMI field which would result in non-compliance (i.e. degradation of science return according to Matt’s criteria). **(AI-2)**
    - During the next instrument ILT (PFM-5), conducted tests on the primary power will be carried out while varying the depth of the AM to verify this principle. The frequency of the AM can also be increased far above the SPIRE band (i.e. 1kHz) to verify that SPIRE is immune to such a modulation of the disturbance **(AI-3)**

- o Filippo: In order to get AM nodulation of EMI field, you need two devices to emit EMI at frequencies separated by <25Hz (Spectrometer bandwidth) and enter a non-linear device.
  - ▪ For DC-DC converters switching in the 100kHz ± 10% this is very unlikely
  - ▪ For clock signals, it is much more likely as they are designed to run at a given frequency within tight tolerances.

3. Cryoharness length

- A calculation of the length of the STM2 cryoharness was made in order to determine the lambda/s resonance frequencies of the PLW detector and bias harnesses. (See Figure 1)
  - o There is some ambiguity in the documentation available to SPIRE due to margins in the length of the harness.
  - o The lengths of the harnesses correspond to the resonant frequency found in the test (~32MHz)
  - o There is some spread in the lengths of the PFM harnesses due to the differences in the routing. DKG to calculate the length of all the harnesses in order to gain an understanding of the range of susceptible frequencies for the different PFM arrays. **(AI-4)**

Bias	SIH-CS-03		1.322 m		
	SIH-IS-03		2.440 m		
	SIH-SS-03		1.547 m		
		Total	5.309 m	λ/2	28.2 MHz
		Total less margin	4.409 m	λ/2	33.9 MHz
PLW	SIH-CS-07		1.208 m		
	SIH-IS-07		2.671 m		
	SIH-SS-07		1.183 m		
		Total	5.062 m	λ/2	29.5 MHz
		Total less margin	4.162 m	λ/2	35.9 MHz

Figure 1

4. SVM Shielding

- The Alcatel outline proposal for shielding the SVM to minimise the EMI field around the external cryoharness was presented (See Appendix 1)
    - Expect to get at least 20dB attenuation outside the SVM
    - There is a theoretical possibility that the fields inside the SVM are raised due to resonances.
    - Nonetheless, it was the assessment of the meeting that a correctly implemented shield would result in an improvement in the EMI susceptibility of SPIRE
    - There are many implementation details to be worked through (design, manufacture, AIT etc.). Alcatel to carry out this detailed assessment work

5. RE Testing of DRCU

- Does to RE testing of the DRCU have to be done on the PFM or could it be done on the QM2?
    - Build standard of the QM2 is very close to flight and therefore, it would be acceptable to submit an RFW and do the qualification on the QM2

Actions

AI	What	Who	When
1	Confirm that the load curves obtained under irradiation during the STM2 campaign were generated with an applied field of 2V/m	DKG	26 Feb. 2006
2	Reprocess STM2 data to compute allowable AM of EMI	DKG	26 Feb. 2006
3	Include a survey of AM modulation depth and AM frequency for the ILT CS testing	DKG	PFM-5 test campaign
4	Calculate the lengths of all SPIRE cryoharness and the corresponding resonant frequencies	DKG	26 Feb. 2006
5	Circulate up-issued report	DKG	26. Feb 2006
6	Discuss EMC susceptibility limit criteria with JJB and BMS	Matt Griffin	26. Feb 2006